Hippocampal Sparing Whole Brain Radiation Therapy Utilizing Rapid Arc Dynamic Technique

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1

Disclosures:

Not incentivized by Varian

Opinions are my own

Retrospective Assessment

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2

2

3

Learning Objectives

An understanding of the hippocampal sparing radiation therapy technique

Insight into Rapid Arc Dynamic treatment planning

What to consider when implementing a new treatment process

4

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History of WBRT

"Old school" dates back to 1950s

- **Tape head, hand blocks for eyes, paper calculation**

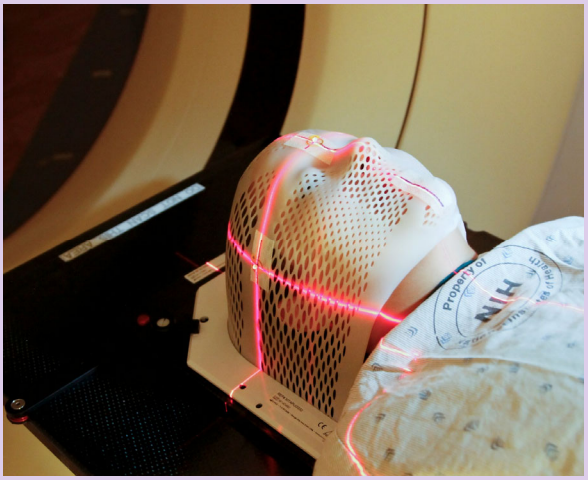
Evolution to 2D/3D

Dose distribution prompted field in field and EZ

PCI

VMAT

VMAT with Hippocampal sparing



5

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Side effects of WBRT

- Temporary hair loss
- Mild dermatitis
- Mild fatigue
- Less likely Otitis Media
- Episodic memory loss
- Decreased fine motor control
- Decreased executive function

6

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Hippocampal function

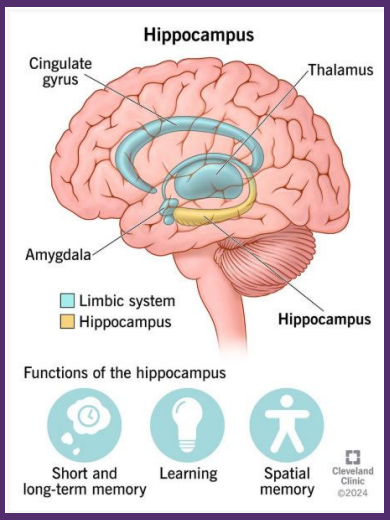
Learning

Short and long-term memory

Spatial memory

Verbal memory

Declarative Memory



Cleveland Clinic. (n.d.). *Hippocampus*. Retrieved May 27, 2026, from https://my.clevelandclinic.org/health/body/hippocampus

7

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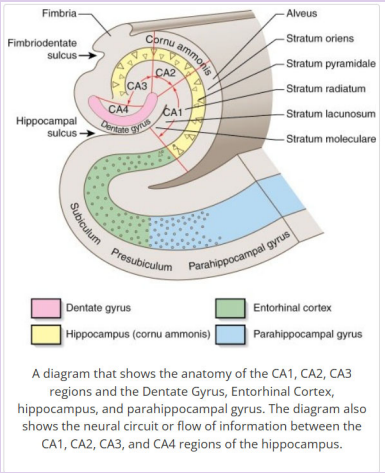
Anatomy of Hippocampus



A diagram that shows the anatomy of the CA1, CA2, CA3 regions and the Dentate Gyrus, Entorhinal Cortex, hippocampus, and parahippocampal gyrus. The diagram also shows the neural circuit or flow of information between the CA1, CA2, CA3, and CA4 regions of the hippocampus.

- Dentate Gyrus
- Hippocampii Proper
- Subiculum
- Entorhinal cortex

8

Exploring the Function of the Hippocampus by Anatomy
September 2, 2018 The Revisionist Bio-Hacking

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RTOG 0933: A Phase II Multi-Institutional Trial

- Hopkins Verbal Learning Test Revised: HVLT-R
- Enrolled 113 patients March 2011- November 2012
- Assessed 42 at 4 months
- Mean Decline in HLVT-R 7%

Table 2. Decline in HVLT-R After HA-WBRT

Time from Baseline (months)	No. of Patients	Mean Relative Decline From Baseline (%)*	95% CI (%)*	Probability of Deterioration (%)†
Total recall				
2	52	13.1	19.5 to 6.7	30.8
4	42	3.6	10.1 to −2.9	19.0
6	29	3.0	5.9 to −12.0	13.8
Immediate recognition				
2	53	10.7	18.3 to 3.1	35.8
4	42	1.6	6.0 to −2.8	11.9
6	28	0.7	4.4 to −3.1	3.6
Delayed recall				
2	53	14.2	24.5 to 3.9	30.2
4	42	7.0‡	18.7 to −4.7	33.3
6	29	2.0	13.1 to −9.2	17.2

Gondi, V. et al. (2014). *Preservation of Memory With Conformal Avoidance of the Hippocampal Neural Stem-Cell Compartment During Whole-Brain Radiotherapy for Brain Metastases.* **J Clin Oncol, 32**(34), 3810–3816. doi:10.1200/JCO.2014.57.2909

9

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Phase III Trial NRG Oncology CC001

This trial concluded that HS WBRT better preserved cognitive function and patient reported symptoms.

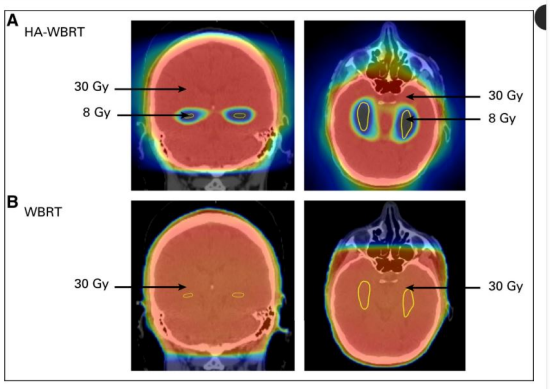

Fig 1. Several-fold reduction in radiation dose to hippocampi (yellow) using (A) hippocampal avoidant whole-brain radiotherapy (HA-WBRT) *v* (B) conventional WBRT.

Brown, P. D. et al. (2020). *Hippocampal Avoidance During Whole-Brain Radiotherapy Plus Memantine (NRG CC001).* **J Clin Oncol, 38**(10), 1019–1029. doi:10.1200/JCO.19.02767

10

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Hippocampal sparing planning

- Dose constraints on the scorecard are applied to the hippocampi (not the HAZ)
- HAZ is standard RTOG definition of hippocampi + 5 mm
- CTV is brain minus HAZ
- PTV is CTV plus an external expansion of 3 mm for setup (since we use IGRT)

11

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Hippocampal sparing goals

FMC_Brain_HippoAvoid_30Gy (FMC Templates) Prescriptions

Use TPS Plan Total Dose as 100%

FMC_Brain_HippoAvoid_30Gy (FMC Templates) Constraints

Priority	Structure Template	Structure Plan	Aliases	Type	Prescription	Constraint Type	Constraint	Comment
1	PTV	1PTV	PTV.*, 1PTV.*	Target	300: 3000cGy	Volume	V95%>95%	
2	PTV	1PTV	PTV.*, 1PTV.*	Target	300: 3000cGy	Dose	D98%>95-8 3%	
3	PTV	1PTV	PTV.*, 1PTV.*	Target	300: 3000cGy	Dose	D2%<107-1 25%	
4	Hippocampus	BiLat_Hipp ocampus	BilatHippoca mpus, Hippocampi	Oar		Dose	D100%<750 -850cGy	
5	Hippocampus	BiLat_Hipp ocampus	BilatHippoca mpus, Hippocampi	Oar		Dose	D0.03cc<13 50-1500cGy	
6	Hippocampus	BiLat_Hipp ocampus	BilatHippoca mpus, Hippocampi	Oar		Dose	D100%<900 -1000cGy	Secondary
7	Hippocampus	BiLat_Hipp ocampus	BilatHippoca mpus, Hippocampi	Oar		Max	Max<1600-1 700cGy	Secondary
8	Lens_L	Lens_L	Lens_L.*	Oar		Max	Max<500cGy	
9	Lens_R	Lens_R	Lens_R.*	Oar		Max	Max<500cGy	

12

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Hippocampal sparing goals

Optic Nerve Left	OpticNrv_L	OpticNerve_L.*, OpticNrv_L.*	OAR	Max	Max<2800cGy
Optic Nerve Right	OpticNrv_R	OpticNerve_R.*, OpticNrv_R.*	OAR	Max	Max<2800cGy
OpticChiasm	OpticChiasm	OpticChiasm.*, Chiasm.*	OAR	Max	Max<2800cGy
Lacrimal_L	Glnd_Lacrimal_L	Lacrimal_L.*	OAR	Max	Max<2000cGy
Lacrimal_L	Glnd_Lacrimal_L	Lacrimal_L.*	OAR	Mean	Mean<1000cGy
Lacrimal_R	Glnd_Lacrimal_R	Lacrimal_R.*	OAR	Max	Max<2000cGy
Lacrimal_R	Glnd_Lacrimal_R	Lacrimal_R.*	OAR	Mean	Mean<1000cGy
Cochlea_L	Cochlea_L	Cochlea L, Lt Cochlea	OAR	Max	Max<3200-4500cGy
Cochlea_L	Cochlea_L	Cochlea L, Lt Cochlea	OAR	Mean	Mean<1500cGy
Cochlea_R	Cochlea_R	Cochlea R, Rt Cochlea	OAR	Max	Max<3200-4500cGy
Cochlea_R	Cochlea_R	Cochlea R, Rt Cochlea	OAR	Mean	Mean<1500cGy

References:
Phase III trial evaluating Memory Preservation of
Prophylactic Cranial Irradiation with or without hippocampal avoidance for small-cell lung cancer
PREMER-TRIAL
J. Krayenbuehl, et al. Improved plan quality with automated radiotherapy planning for whole brain with hippocampus sparing: a comparison to the RTOG 0933 trial.
SWOG S1827

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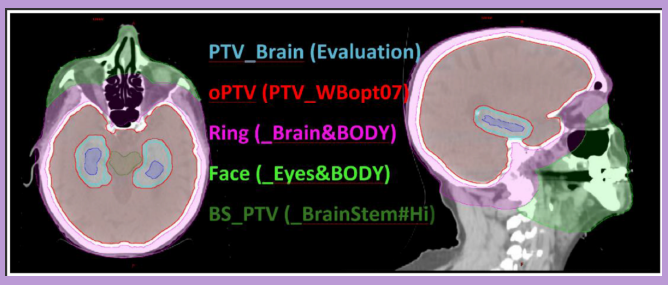
Rapid Plan

Whole brain w/ hippocampal sparing

(NRG-CC001) [RP (HSWBv2)]

Version 2 demonstrated improved hippocampal sparing



Liu, H. et al. (2022). *RapidPlan hippocampal sparing whole brain model version 2—How far can we reduce the dose?* Med Dosim, 47(3), 258–263.

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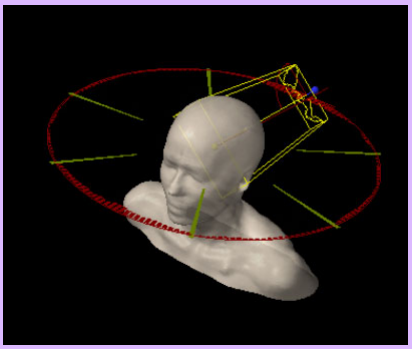
14

Rapid Arc Dynamic Introduction: What is RAD?

Rapid Arc Dynamic or RAD enables the use of a dynamic collimator and Static port placement (STAMPs)

Deterministic algorithm results in the same dose distribution for the same arc angles and optimization goals



15

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RAD at Forsyth Medical Center

August 25, 2025

First in the nation to deliver RAD treatment

16

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Early adopter challenges

- Training in test environment
- What functionality to embrace
- What cases to prioritize
- Best Practice
- Resource allotment

17

Rapid Arc Dynamic Introduction: Starting a plan

Insert new Rapid Arc Dynamic Plan

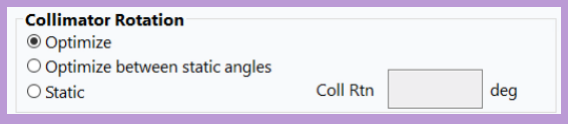
Arc Tools:

Set Arc span

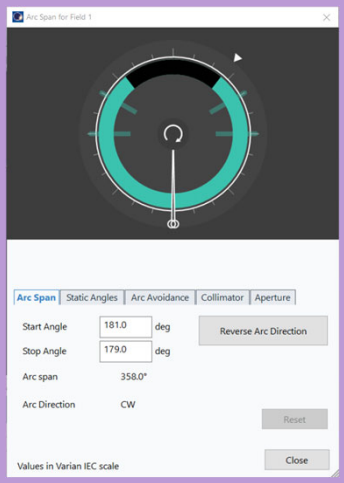
Static angles: Insert STAMPs

Arc Avoidance: Do not enter/exit not an option

Collimator

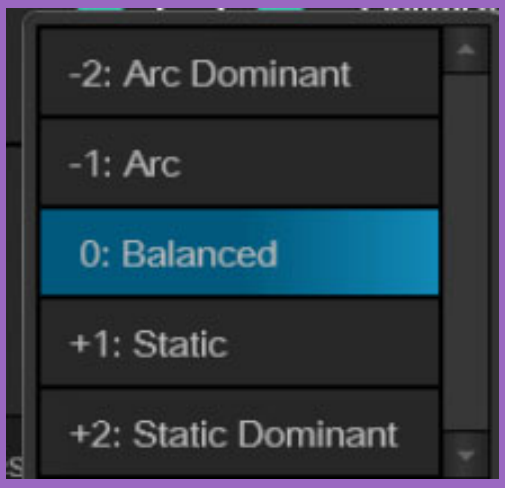


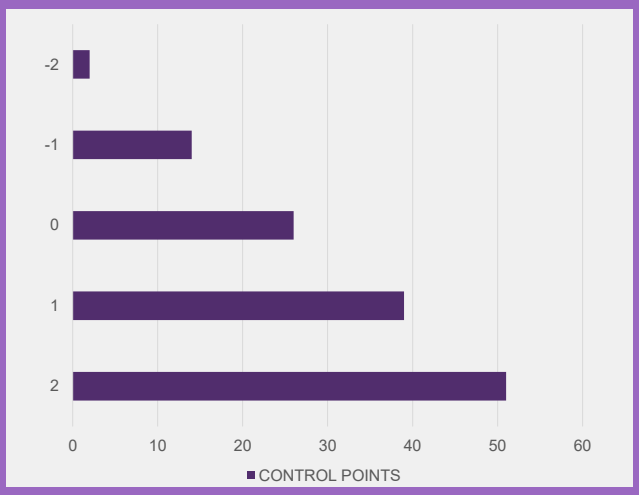
Aperture: ideal to set to 15 cm in width



18

Rapid Arc Dynamic Introduction: Stamp Contribution





19

Clark, R. (n.d.). *RapidArc Dynamic: Insights for Treatment Planning* [AAMD webinar].

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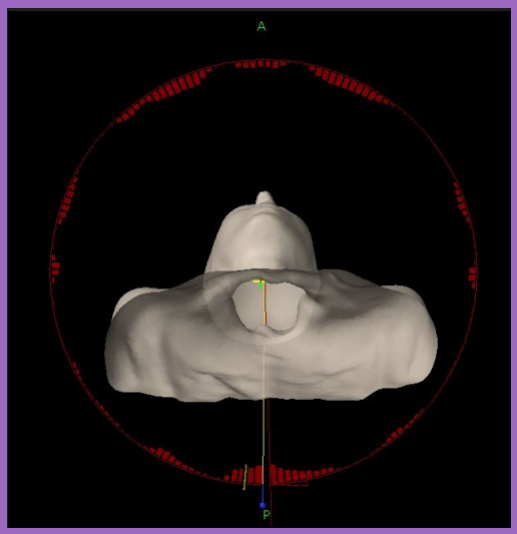
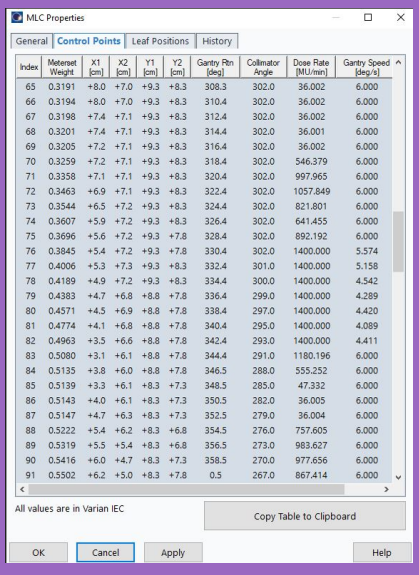
Rapid Arc Dynamic Introduction: Where to place STAMPS





20

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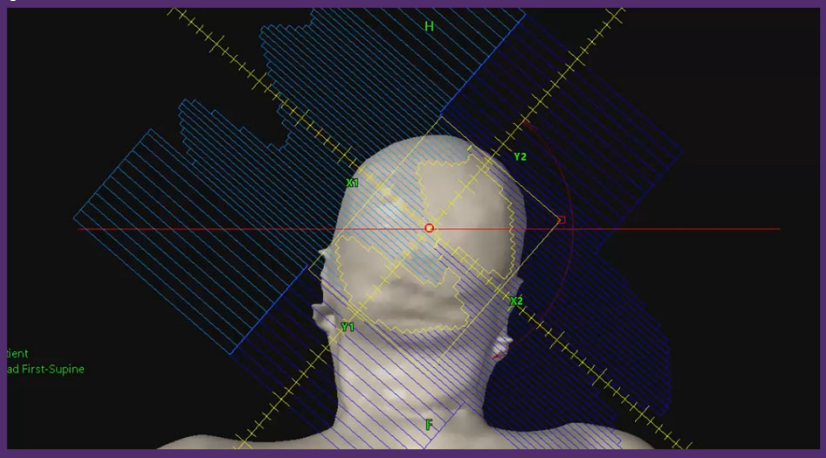
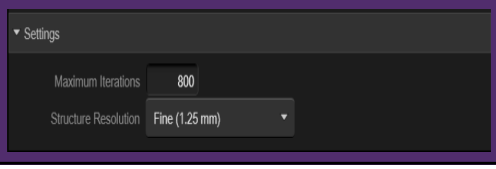
Rapid Arc Dynamic Introduction





Iterations: 100 – 4000
Structure resolution: Fine or normal

21

21

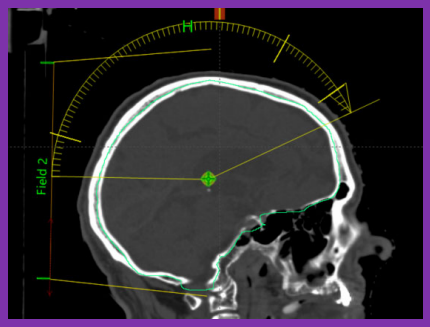
RAD compatibility

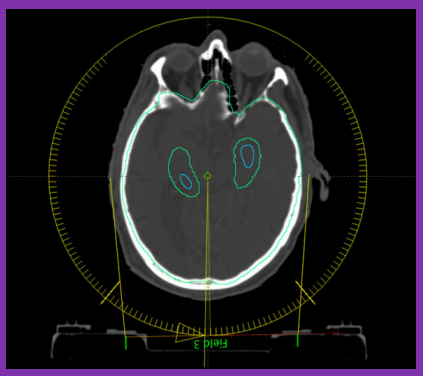
Rapid Plan	Templates • Plan starter • Optimization template	Scripting
MCO	NTO	Clinical goals

22

22

Case 1: PCI





RAD: 2 Full arcs with avoidance sector and 1 Vertex + 1 Static

Initial: 2 Full arcs & 1 vertex with do not enter eyes

23

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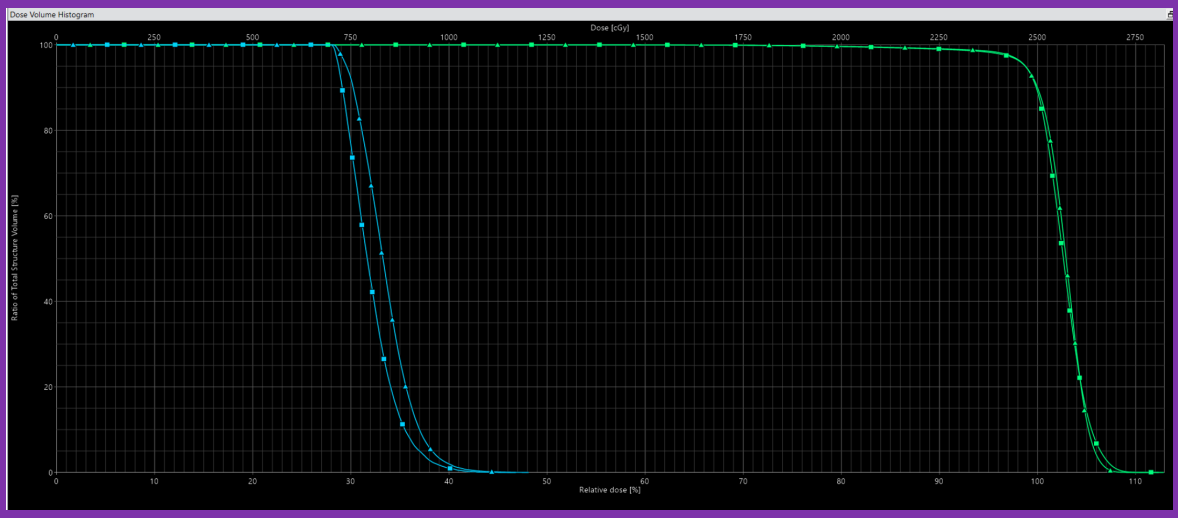
Case 1



24

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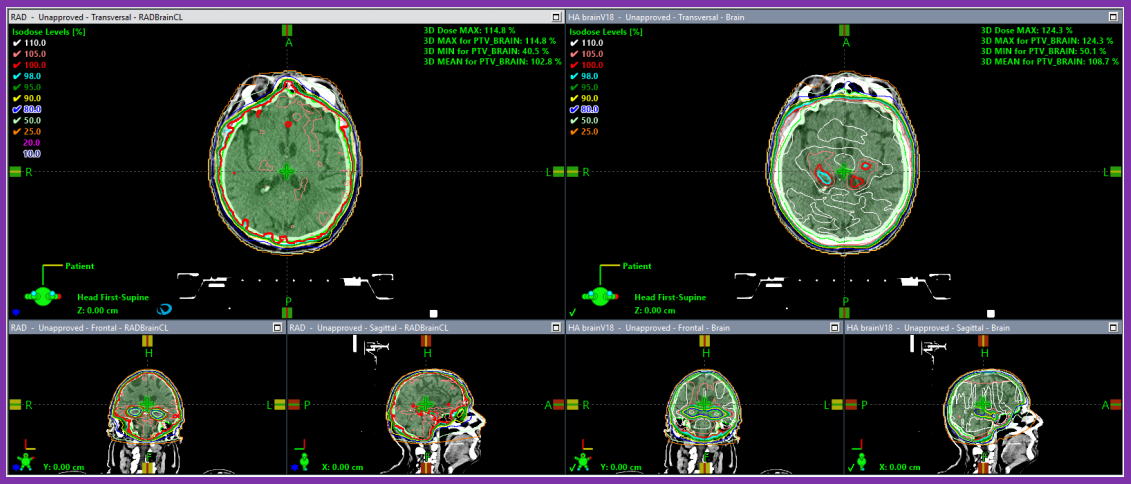
Case 2:



RAD: 2 Full arcs with arc avoidance on 1 arc + 1 Static
Initial: 2 Full arcs with do not enter eyes and 2 vertex arcs

25

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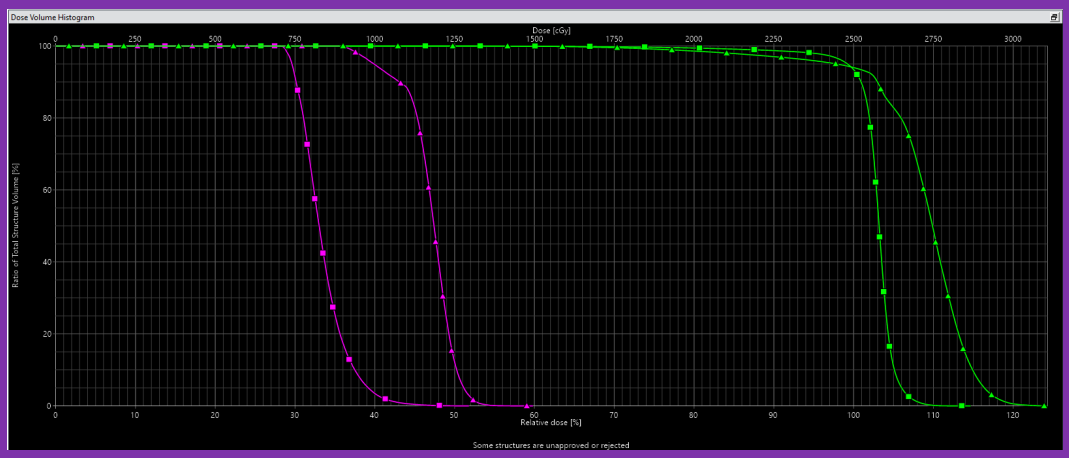
Case 2:



26

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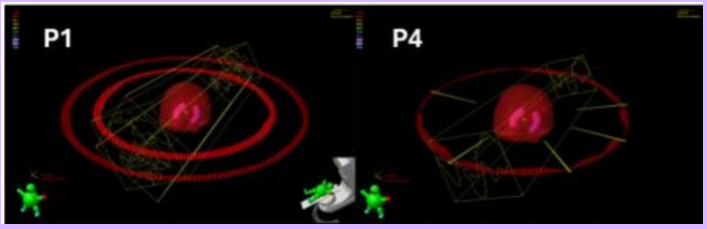
Retrospective Assessment versus Research

RAD one arc VMAT with 6 templated stamps produced lower hippocampal doses at D100% and a higher D98% of PTV coverage



Kim, G. G., Kisling, K., & Ray, X. *Improved Hippocampal Sparing in Whole-Brain Radiotherapy Using VMAT with Optimized Dynamic Collimator Rotation and Modulated Ports* [Research poster]. Radiation Medicine & Applied Sciences, UC San Diego.

27

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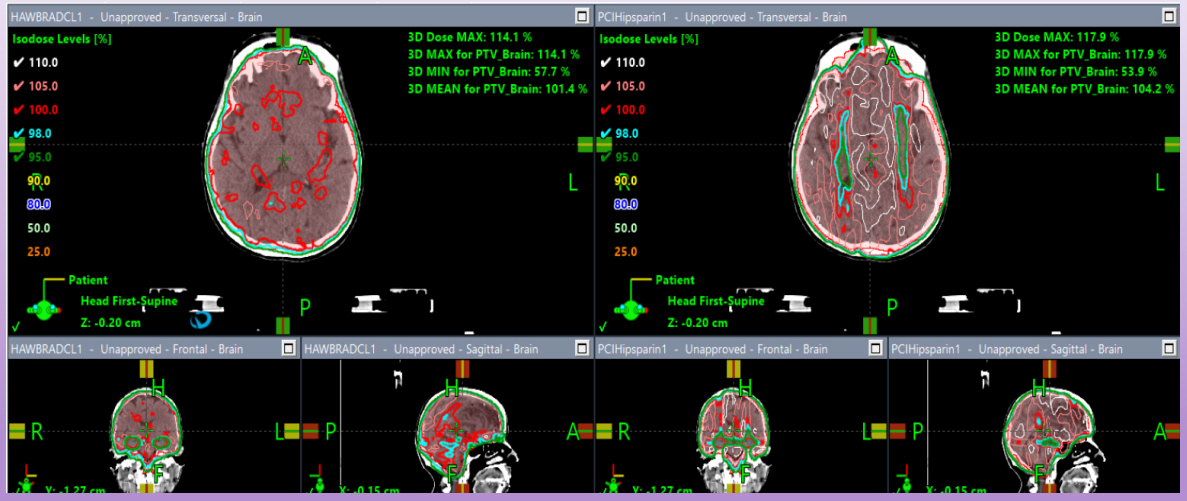
Case 3:PCI



RAD: 1 Full arc with 6 STAMPS +2 Static Dominant no arc avoidance sectors
Initial: 2 Full arcs with do not enter eyes and 2 vertex arcs

28

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Case 3:

29

29

Plan Assessment: What is most important in plan comparison

- Scorecard
- Isodose lines
- MD Preference
- Arcs
  - Patient anxiety
  - Increased throughput
- Novelty of new technology

30

30

Rapid Arc Dynamic Limitations and Considerations

General

- Optimizer not interactive
- Unable to use OAR do not enter/exit

Departmental

- One Linac license
  - Limit cases
  - What happens when machine is down
- One planning license
  - Patient planning
  - Research
  - Training
- Acuros not fully commissioned

31

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References:

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Cleveland Clinic. (n.d.). *Hippocampus*. Retrieved May 27, 2026, from https://my.clevelandclinic.org/health/body/hippocampus

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32

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32